



George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

QD-R-005
REVISION G

EFFECTIVE DATE: September 24, 2004

ORGANIZATIONAL INSTRUCTION

FAILURE REPORTING ANALYSIS AND CORRECTIVE ACTION

OPR(s)

**QD10, QD20, QD30,
and QD40**

OPR DESIGNEE

John McPherson

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DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		11/20/97	
Revision	A	06/23/98	Add locations of referenced documents in table format; Words generalized for in-house development; Converted quality records to table format
Revision	B	06/29/99	Revised for new document numbers in MSFC directives system and MSFC organizational changes
Revision	C	12/8/00	Revised to include more details on Specific Processing Tasks, per NQA finding (ref. NCR 00/35812/S05-MSFC #2
Revision	D	9/09/02	Format and numbering change to implement requirements of QS-A-001 rev F.
Revision	E	9/20/02	Administrative changes only for revised S&MA organizational codes; viz., from QS10 to QS40
Revision	F	03/04/04	Replace "hardware" with "hardware/software" throughout; Delete definition for unused term "in-family"; Update retention rationale per MSFC Records Manager input.
Revision	G	9/24/04	Revised to bring document in compliance with the HQ Rules Review Action (CAITS: 04-DA01-0387). Changes were also made to reflect S&MA organizational name changes (i.e., QS to QD). Also, 4 new reference documents have been added. Clarified person charged with specific actions; Defined S&MA Project Assurance Team; Corrected ISS document identifier to SSP; Made bi-annual on-site survey mandatory along with correcting found errors in the MSFC PRACA database.

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Failure Reporting Analysis and Corrective Action

1. PURPOSE, SCOPE, APPLICABILITY (As Required)

1.1. Purpose - The purpose of this Organizational Instruction (OI) is to provide procedures that shall be used in establishing, maintaining, and reviewing problem reporting requirements for flight hardware/software developers and to specify procedures for MSFC S&MA's receipt, coding, distribution, review, coordination, and tracking of Problem Reporting and Corrective Action (PRACA) problem reports by the MSFC PRACA coordinators and S&MA Project Assurance Team actionees.

1.2. Scope – This OI describes the S&MA Project Assurance Team responsibilities that shall be performed for flight hardware/software failure reporting and corrective action functions which are currently or may be designated in the future by the relevant Project Manager to participate in MSFC PRACA problem reporting.

1.3. Applicability – This OI shall be applicable to S&MA Project Assurance Team's support for all Projects which are designated for participation in MSFC PRACA system requirements or Project Manager direction.

2. DOCUMENTS (Applicable and/or Reference)

2.1. Applicable Documents

NPD 8720.1	NASA Reliability and Maintainability (R&M) Program Policy.
NSTS 5300.4 (1D-2)	Safety, Reliability, Maintainability and Quality Provisions for the Space Shuttle Program.
NSTS 08126	Space Shuttle Problem Reporting and Corrective Action System Requirements
SSP 30223	Problem Reporting and Corrective Action System Requirements for the International Space Station Program
NPD 8700.1B	NASA Policy for Safety and Mission Success
MPD 8720.1	MSFC Reliability and Maintainability Program for Space Systems

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NPR 8705.2 Human-Rating Requirements for Space Flight System

NPD 8700.2 NASA Policy for Safety and Mission Assurance (SMA) for Experimental Aerospace Vehicles (EAV)

NPR 8715.3 NASA Safety Manual

2.2. Reference Documents – None

3. DEFINITIONS

Definitions applicable to this OI are addressed in detail in the NSTS 08126 and the SSP 30223 documents.

Specific definitions relative to this instruction are:

3.1 Anomaly. An unexpected event, hardware or software damage, a departure from established procedures or performance, or a deviation of system, subsystem, and/or hardware or software performance outside certified design/performance specification limits.

3.2 Closed Problem. A problem which the design element has approved as resolved based on the determination of the cause(s) or probable cause(s) and flight rationale, and the definition of the corrective action, or that no corrective action is required.

3.3 Corrective Action. Action approved by the appropriate design element authority to correct a problem which includes one or more of the following:

- a. Design change
- b. Manufacturing method/procedure/process change
- c. Test or operating procedure change
- d. Training or certification of personnel
- e. Maintenance procedure change
- f. Limit time or cycle of component
- g. Transportation or shipping change
- h. Remedial action/repair

3.4 Criticality. a. Functional criticality – Categorization of the effect of loss of all redundancy (like and/or unlike) for a given function; b. Hardware criticality – Categorization of the singular effect of the identified failure mode of a hardware item; c. Operational criticality – Categorization of the operational effect of loss of a function as specified in Failure Mode Effects Analysis.

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3.5 Dispositioned Problem. A problem that has been closed or interim closed.

3.6 Failure. The inability of a system, subsystem, component, or part to perform its specified function within specified limits, under specified conditions, and for a specified duration.

3.7 Failure Modes and Effects Analysis (FMEA). A description of the manner in which an item can fail and the resulting effects on the system, interfacing system, mission, and crew/vehicle.

3.8 Generic Problem. A problem condition that could exist on any or all components of like or similar design.

3.9 Interim Closed Problem. A problem which the design element has approved as not constraining specified flights based on the criteria in the respective PRACA requirements document.

3.10 Nonconformance. A condition of any article or material in which one or more characteristics do not conform to requirements.

3.11 Probable Cause. The event or series of events occurring at the lowest level of assembly which failure investigation/analysis indicates is likely responsible for the problem.

3.12 Problem. Any nonconformance falling within the applicability of this or appropriate NASA PRACA requirements document.

3.13 Problem Cause. The event or series of events occurring at the lowest level of assembly which is directly responsible for the problem.

3.14 Problem Reporting and Corrective Action (PRACA). A management system for identifying, reporting, analyzing for cause, remedying, and preventing recurrence of problems.

3.15 Recurrence Control. Preventive action beyond remedial action taken to preclude or minimize the recurrence of a problem in existing and future hardware or software; e.g., design change, procedure change, or process change, etc.

3.16 Remedial Action. Action taken to bring a specific failed unit to operational status or to eliminate an unsatisfactory condition on the specific unit; e.g., remove-and-replace, rework-to-print, MRB disposition, etc.

3.17 Reportable Problem. Any nonconformance falling within the reporting requirement applicability of this or the applicable NASA PRACA requirements document.

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3.18 S&MA Project Assurance Team. Team comprised of QD civil servant and their S&MA support contractors assigned to work a specific project.

3.19 Unexplained Anomaly. An anomaly (ghost or phantom) which cannot be repeated or for which a cause cannot be determined.

4. INSTRUCTIONS

Except for certain in-house projects, PRACA-reportable problems shall be generated by hardware/software prime contractors according to contract specifications. Specific rules regarding reporting requirements for the hardware/software element shall be stated in the applicable contract or memo of understanding, which shall reference the relevant NASA standard PRACA reporting and processing requirements, as stated in NSTS 08126 (for Space Shuttle projects and Shuttle payloads) or SSP 30223 (for Space Station-related projects and ISS experiments and/or payloads), or similar.

4.1 Problem Reporting Requirements. When an MSFC Project is being defined and requirements are being developed, the S&MA Project Assurance Team Lead shall coordinate with the Project Manager regarding problem reporting. Involvement in MSFC PRACA shall be strongly recommended if the Project:

- will be involved in multiple missions;
- requires significant time and finances for design, development, and implementation; or
- provides significant risk for safety of the crew and/or functioning of crew support facilities.

The designated S&MA project assurance organization shall evaluate issues regarding significance, shall discuss with the Project Manager use of MSFC PRACA as a method for mission risk management, and shall encourage authorization of funds for including PRACA reportability and processing as a requirement. If approved by the Project Manager, the S&MA Project Assurance Team representative shall assure that requirements for PRACA processing and reporting into MSFC are included, in keeping with NSTS 08126 or SSP 30223 or other applicable document. Adaptations in problem processing requirements to meet specific needs of the project shall be allowed, as long as they satisfy minimum requirements of the applicable document for timeliness, visibility, and adequate problem investigation and resolution.

During the life of the project, S&MA Project Assurance Team shall participate in reviewing the developer's effectiveness in implementing PRACA reportability requirements and shall assist in maintaining requirements current against changes in the governing NASA document. The

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applicable S&MA Project Assurance Team shall coordinate issues regarding problem reporting compliance by the hardware/software developer with the Project Office, contracts, contract evaluation boards, and the developer as appropriate to maintain adequate visibility and to correct discrepancies. This shall include on-sight survey at least once every two years and frequent remote monitoring of developer/manufacturer/ integrator process requirements, procedures, and implementations and historical records of nonconformance screening for PRACA reportability determination.

4.2 Failure Analysis And Corrective Action Report Processing. When a PRACA-reportable problem report is received at MSFC S&MA, the designated MSFC S&MA Project Assurance Team PRACA representative :

- shall assign it a unique MSFC PRACA number for tracking purposes
- shall review it for accuracy, consistency, and completeness
- shall code it to meet standards of the applicable NASA requirements document and MSFC PRACA
- shall enter it into the MSFC PRACA data system (reference Appendix A for mandatory and expected data fields)
- shall store it into a complete problem information data file (in hardcopy or electronic image)

Following clarification and/or correction of apparent problem report discrepancies, the designated S&MA Project Assurance Team PRACA representative shall circulate the problem report information to the S&MA project assurance organization, the Project Manager, and other designated MSFC Project Actionees (such as the Chief Engineer). The designated S&MA Project Assurance Team PRACA representative shall maintain a list of actionees for the various projects, systems, and subsystems.

The designated S&MA Project Assurance Team PRACA representative shall also verify, code, enter into the data and storage files, review, and circulate, as appropriate, incremental problem report updates and problem disposition recommendations. Related problem historic trends shall be included in the circulated information when available, but especially when provided for problem disposition. (Reference Appendix A for typical trend techniques.) Adequacy of disposition shall be evaluated by the S&MA Project Assurance Team against analysis and disposition requirements of the applicable NASA document. The S&MA Project Assurance Team shall coordinate approval of problem disposition through the Project Manager and the other designated problem actionees. Following concurrence in problem disposition within MSFC, the hardware/software developer shall be informed of the approval and/or any additional required action by the designated S&MA Project Assurance Team PRACA representative.

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Problem disposition shall be recorded in the PRACA data system by the designated S&MA Project Assurance Team PRACA representative, to include status, effectivity of disposition (by date, mission, or specific hardware/software), and remaining/additional activities required for full problem closure, if any. Software techniques shall be applied by the designated S&MA Project Assurance Team PRACA representative to indicate full or temporary closure and to leave or restrict further update of the problem through automatic data loads. (Reference Appendix A for coding of various problem dispositions.

4.3 Problem Visibility. The designated S&MA Project Assurance Team PRACA representative shall participate in project and mission milestones to report status of applicable open critical hardware/software problems from MSFC PRACA. When needed, the S&MA Project Assurance Team PRACA representative shall research open issues and seek to justify performance of the project or milestone step to the appropriate review board. Should an open problem be evaluated by the S&MA Project Assurance Team as a potential constraint to a project or mission milestone, the S&MA Project Assurance Team shall bring this issue to the attention of the applicable NASA review board in a timely manner for their evaluation.

5. NOTES

None

6. SAFETY PRECAUTIONS AND WARNING NOTES

None

7. APPENDICES, DATA, REPORTS, AND FORMS

Performing failure reporting and corrective action functions shall use the MSFC UNIX PRACA Data System and associated server and/or other problem data systems, as applicable. On-line forms included in these application shall be submitted and reviewed by MSFC PRACA coordination personnel to establish user access and level-of-authority. Details on certain specific processes are provided in Appendix A.

8. RECORDS

The following records shall be kept and maintained by the S&MA Office:

<u>Record</u>	<u>Repository</u>	<u>Period of Time</u>
MSFC PRACA problem records (Electronic) QD40: OPR	QD40: Designated Problem Assessment System (PAS) lead - Maintained Electronically on MSFC	NPR 1441.1, Record Retention Schedule 5/28

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	UNIX PRACA data tables within the UNIX PRACA server	Destroy 10 years after end of the project <DA: N1-255-94-2>
MSFC PRACA problem files (Hardcopy) QD40: OPR	QD40: Designated Problem Assessment System (PAS) lead - Maintained manually in hardcopy files located in Building 4471, Room C111.	NPR 1441.1, Record Retention Schedule 5/28 Destroy 10 years after end of the project <DA: N1-255-94-2>

9. TOOLS, EQUIPMENT, AND MATERIALS

Computer system housing MSFC PRACA data system, along with associated communication networks and peripherals.

10. PERSONNEL TRAINING AND CERTIFICATION

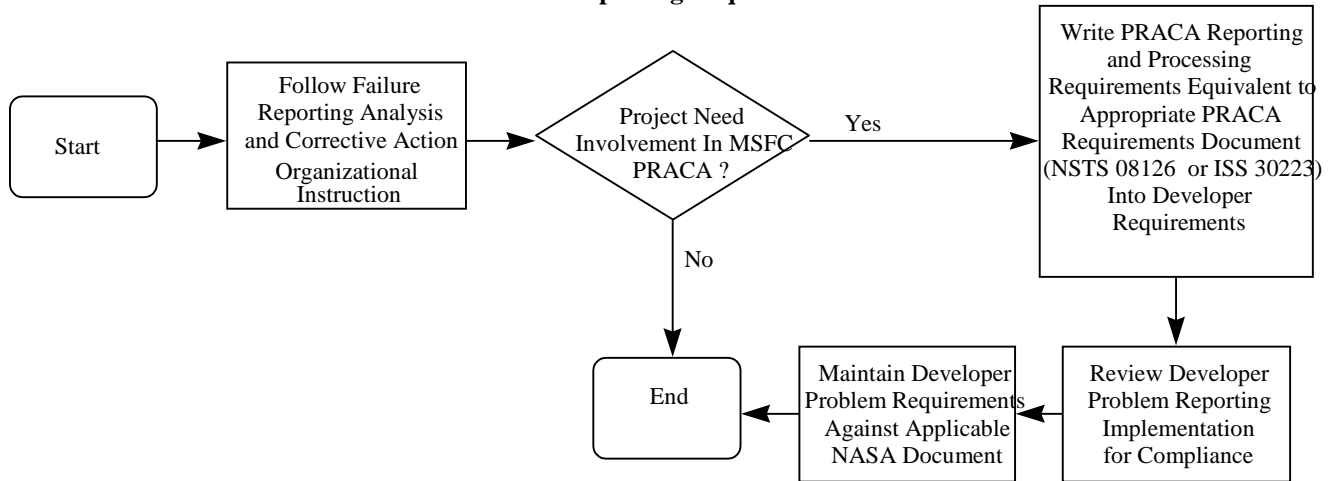
No formal training shall be required in performing failure reporting and corrective action functions. Knowledge of associated project hardware/software, NASA requirements, and computer application are desirable and can be obtained through on-the-job training, on-line training modules, experience, and/or participation in the annual training class on this operating instruction and the Problem Assessment Center Operations Plan.

11. FLOW DIAGRAM

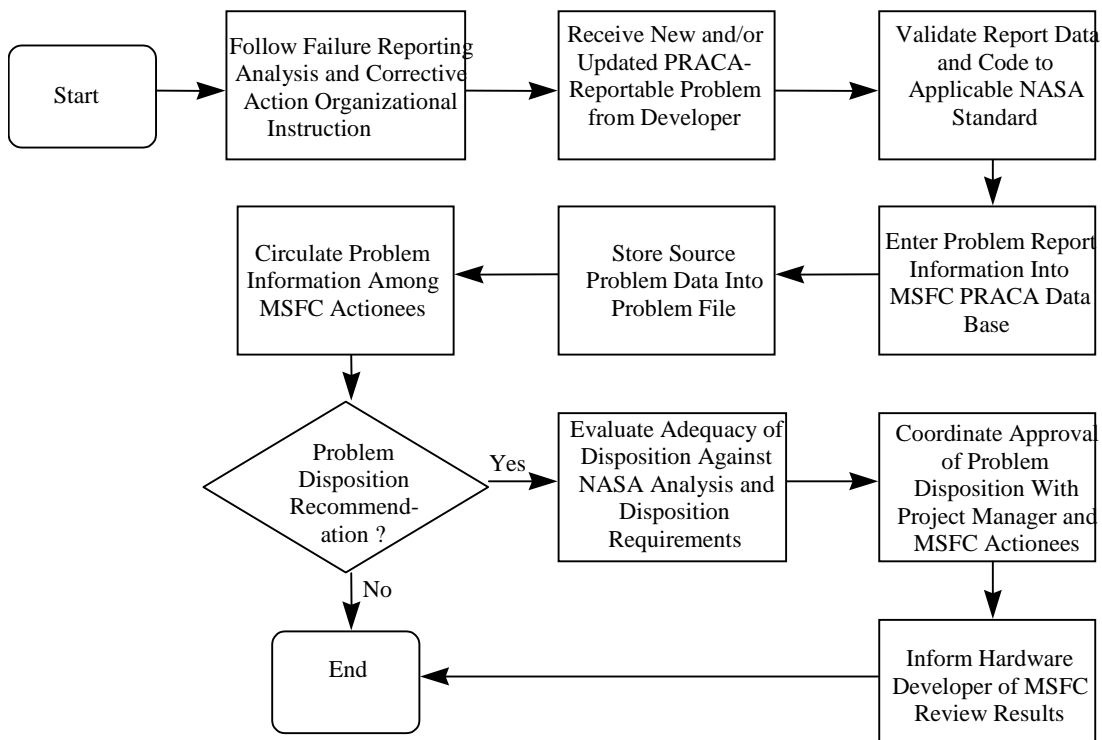
The following flow diagrams indicate the sequence of operations to be followed when performing failure reporting and corrective action functions by MSFC S&MA:

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a. Problem Reporting Requirements

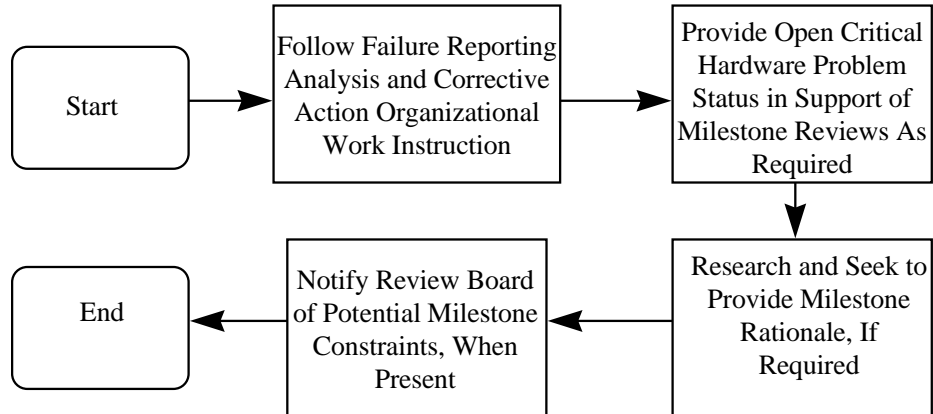


b. Failure Analysis and Corrective Action Report Processing



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c. Problem Visibility



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APPENDIX A. SPECIFIC PROBLEM PROCESSING TECHNIQUES

The following criteria only apply to projects using MSFC UPRACA as the data base. It does not apply for those using ISS PRACA-on-the-Web or other equivalent data systems.

A.1 Mandatory and Expected Data Fields. The following lists provide guidance in which data fields are required for initial problem entry, expected by full problem closure, or purely optional.

Mandatory data field entries upon problem entry are:

- MSFC Record Number
- Contractor Report Number
- Element
- System
- Received Date
- Status

Other desired (but not mandatory) data field entries upon initial entry are:

- Contractor
- Functional Criticality
- The following pairs of data for at least one of Nonconforming Article (NCA), Line Replaceable Unit (LRU), or End Item Model (EIM):
 - Nomenclature
 - Part Number
- Test/Operation Code
- Prevailing Condition Code
- Failure/Unsatisfactory Condition
- Work Contact
- Failure Date
- Date Isolated
- FMEA Reference
- Location
- Design Assignee
- Chief Engineer Assignee
- S&MA Assignee
- Project Manager Assignee
- PAS Assignee
- Problem Description

Fields that are expected to be present by full problem closure are:

- Problem Title
- Contractor
- Functional Criticality

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- The following pairs of data for at least one of Nonconforming Article (NCA), Line Replaceable Unit (LRU), or End Item Model (EIM):
 - Nomenclature
 - Part Number
- Test/Operation Code
- Prevailing Condition Code
- Failure/Unsatisfactory Condition
- Cause Code
- Defect Code
- Material Code
- Work Contact
- Failure Date
- Date Isolated
- FMEA Reference
- Location
- Symptom Code
- Last MSFC Update
- Date Contractor Resolution Submitted
- Add Date
- Recurrence Control Code(s)
- Design Assignee
- Chief Engineer Assignee
- S&MA Assignee
- Project Manager Assignee
- Design Approval (if not Nonproblem)
- Chief Engineer Approval (if not Nonproblem)
- S&MA Approval
- Project Manager Approval (if not Nonproblem)
- PAS Assignee
- PAC Review Complete
- MSFC Close Date
- Problem Description
- Contractor Investigation/ Resolution
- MSFC Response/Concurrence
- Assessment Part Number
- Assessment Part Name
- Assessment Functional Criticality
- Assessment Cause Code
- Assessment Failure Mode
- Assessment FMEA

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All other data fields are considered optional; however, if values are known for any of the other data fields, those values should be included in the data base.

A.2 Typical Trending Techniques. The purpose of problem trending is to provide a summary of related problems for use in problem analysis – specifically to show frequency of occurrence, effectiveness of recurrence control, and tendencies toward more or less frequent occurrences of similar problems. Typical styles of problem trending are described below.

One-Line Trending by Part Number consists of a listing of basic data for problems having matching (completely or partially) part numbers. Since part number information is usually available from initial problem submittal, it can usually be performed early in the problem processing cycle. Problem data is usually sorted by Failure Date, Part Number, MSFC Record Number, or a combination of these field values. The MSFC UPRACA pre-defined or user-defined one-line listings (except for the Problem Trend 1-Liner which is based on the Assessment Addendum data which is not always present) can be used as output formats.

One-Line Trending by FMEA Reference consists of a listing of basic data for problems having matching (completely or partially) FMEA References. If FMEA Reference is known, this is usually a better way to query the database for directly related types of failures/nonconformances. Problem data is usually sorted by Failure Date, FMEA Reference, MSFC Record Number, or a combination of these field values. The MSFC UPRACA pre-defined or custom one-line listings (including the Problem Trend 1-Liner based on the Assessment Addendum data, if that data is present) can be used as output formats.

Graphical trending begins with one of the above query / extract techniques but then presents results in a bar or line graph chart – usually using Excel spreadsheet capabilities as a tool. Data is collected by counts per year and illustrated as bars or points on a graph. If available, normalization of raw problem counts per year can be performed by dividing the problem counts per year by opportunities for failure (starts, seconds, items tested, tests performed, items delivered, etc.) during similar time frames. This changes problem counts to problem rate per normalization data for that year. If normalization is performed, both the raw and normalized data is normally shown on the chart. Trend lines can also be added, again using standard Excel spreadsheet chart capabilities.

Statistical trending continues from normalized graphical trending to use statistical concepts such as correlation coefficient and random data measures to determine significance of identified trends. Linear, exponential, quadratic, logarithmic, and similar trend models are applied, with the best fit evaluated to determine if the model is a good fit for the data. If the fit is adequate the trend is identified as adverse (i.e., frequency of this type of problem is not decreasing over time) or not adverse. Adverse trends are to be identified and provided to the S&MA respective Project Assurance team for their evaluation.

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A.3 Coding Problem Dispositions. Problems may be dispositioned as a Closed-Nonproblem, Interim Closed (also referred to as Closed with Action or Closed-Pending Action), or Fully Closed. All dispositions should be documented with signed hardcopy source documents added to the PAC problem file and notification to the involved parties, in keeping with preferred Project techniques. Specific instructions regarding data entries for each type of disposition are as follows:

For a Closed-Nonproblem (Closed-N), the word NON-PROBLEM is to be entered at the end of the Problem Title, the Status is set to N, and only the S&MA Approval is required (as opposed to all of Design Approval, Chief Engineer Approval, S&MA Approval, and Project Manager Approval).

For Interim Closure (Closed-P),

- set STATUS to P.
- set MISC_CODE_H to C (to tell the data base loader software to accept more updates from the contractor for the problem without human review).
- set DATE OF LAST DEFERRAL to the date when the Closed-P was approved by the Project Manager or Problem Review Board;
- add a comment to MSFC RESPONSE / CONCURRENCE stating that Closed With Action was approved on mm/dd/yyyy and reference the extent of the effectivity, such as until the date when the action is due to be completed as assigned by NASA or the hardware/software sets for which the interim closure rationale is applicable.
- record the effectivity (as described above) in the EFFECTIVITY TEXT field.
- make sure that an appropriate interim closure rationale (as defined in the applicable NASA PRACA requirement document) is present either here or in the Contractor INVESTIGATION / RESOLUTION text field. A clear statement of mission/flight rationale, action(s) to be accomplished, and a plan of action (POA) schedule are also to be present, unless approval of the Interim Closure is performed in expedited Launch-Imminent mode (i.e., within one week prior to scheduled mission) with only flight rationale.
- do NOT include the ASSIGNEE APPROVAL entries. That should be left for final closure.
- if effectivity is based on date, set the ESTIMATED COMPLETION DATE: FAILURE ANALYSIS DATE to the NASA-approved deadline date for completion of contractor action. This date will be used by the PAC for monitoring contractor compliance with the schedule and for re-opening the problem if the date is not met and no revision in the deadline has been approved by NASA. It is also used as a parameter in extracting data for input to various S&MA and Project milestone reviews.

For Full Closure (Closed or Closed-Explained), fill in all of the data fields for which values are known (reference A.1 above) and specifically

- set the STATUS to Closed or Closed-E, as appropriate.

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- add the names in the respective ASSIGNEE APPROVALs of the assignees who authorized full closure.
- clear out any value in MISC H (unless there is specific direction to accept additional contractor update, in which case clearing the MISC H flag to blank is to be performed after the specified additional data has been received).
- perform a final review of all data base entries, assuring the accuracy of data based on source documents and other factual information. If an inaccuracy is identified, the data shall be corrected and the correction communicated to involved parties.
- sign off on hardcopy problem report file and turn it in for archive storage in the master PAC files.